SA Series

NEW SA
PRODUCT MANUAL

USB REAL-TIME SPECTRUM ANALYZER

SAN Series
4.5/6/9 GHz

V1.4
08/10/2026

HAROGIC

SAN Series Overview

BENCHMARK USB SPECTRUM ANALYZER

The SAN series features a high-performance superheterodyne receiver with up to 14-stage preselection filters, delivering excellent noise performance, dynamic range, interference immunity, and fast analysis speed.

EASE OF USE AND COMPACT DESIGN

The compact form factor allows easy system integration while maintaining high RF performance such as spectral purity, making it well suited for space- and cost-constrained applications.

UNIFIED AND POWERFUL API

All models share a unified API, enabling seamless hardware migration without code changes. Supports C/C++, C#, Python, MATLAB, Qt, LabVIEW and GNU Radio on Windows and Linux.

RICH MEASUREMENT FUNCTIONS

Standard measurement functions include channel power, occupied bandwidth, XdB bandwidth, harmonic measurements, AM/FM demodulation, and automatic phase noise measurement.

Key Features

- High-performance superheterodyne receiver with up to 14-stage preselection filters
- Frequency range: 9 kHz to 4.5/6/9 GHz
- 1 GHz DANL: -168 dBm/Hz
- 9 GHz DANL: -167dBm/Hz
- 1 GHz phase noise: < -110 dBc/Hz@10 kHz
- 1 GHz phase noise measurement: < -125 dBc/Hz@10 kHz
- Analysis bandwidth: 50 MHz / 100MHz (opt.50)
- Sweep speed: ≥ 1 THz/s (RBW = 250 kHz)
- IF and image rejection: > 95 dBc
- Built-in GNSS, supports frequency calibration
- USB3.0/2.0 Type-C interface
- Provides rich APIs and example programs
- Supports Windows 11/10/8/7 (x86, x64)
- Supports Debian 12/11/10 (x64, AArch64)
- Supports Ubuntu 24.04/22.04/20.04/18.04 (x64, AArch64)
- Supports standard SCPI protocol

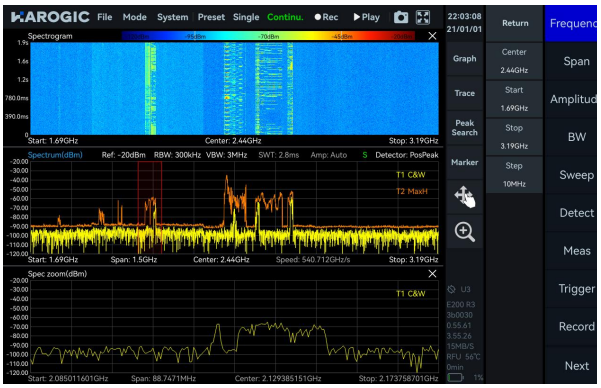
Main Operating Modes Overview

Offer multiple primary operating modes: Standard Spectrum Analysis mode, IQ Streaming mode, Power Detection Analysis mode, Real-Time Spectrum Analysis mode, Phase Noise Measurement, Basic Vector Modulation Analysis mode (opt.71), Pulse Analysis (opt.72), Harmonic Analysis mode and EMI Pre-Compliance Measurement (opt.74).

SAStudio4 Main Operating Modes Description

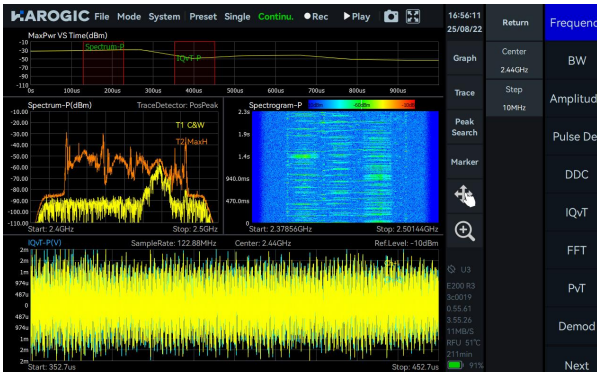
■ Standard Spectrum Analysis Mode

This mode provides a wide range of measurement functions, including full-span spectrum sweep, channel power, OBW, ACPR, IM3 and SEM. It also supports spectrum recording and playback. Combined with auxiliary tools such as signal tracking, peak table, and amplitude correction, it delivers a one-stop platform for comprehensive spectrum check.



■ IQ Streaming Mode

This mode supports up to 100 MHz analysis bandwidth and allows IQ data acquisition through multiple trigger methods. It provides IQ time-domain waveform display, spectrum and spectrogram views, AM/FM demodulation, and digital down conversion (DDC).

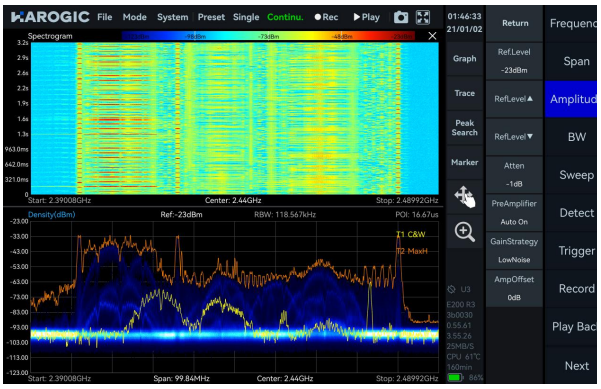


■ Power Detection Analysis Mode

This mode enables detection and analysis of time-domain signals within the analysis bandwidth, making it suitable for applications focused on in-band power-versus-time relationships, such as pulse signal measurements.

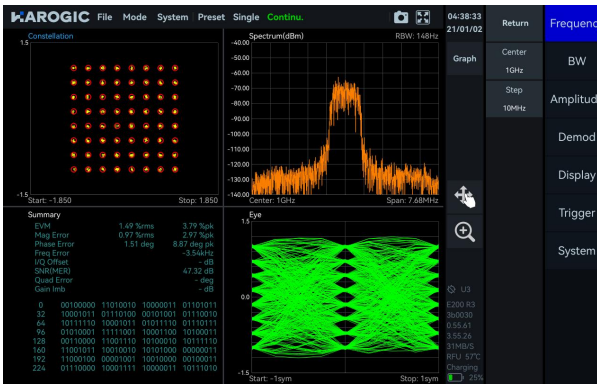
Real-time Spectrum Analysis Mode

This mode is powered by a high-speed FPGA-based FFT engine, featuring with strictly gapless and overlap-free FFT, achieving true real-time monitoring across the full bandwidth.



Basic Vector Modulation Analysis Mode (opt.71)

This mode supports 2ASK, 2FSK, 4FSK, GMSK, BPSK, QPSK, 8PSK, 16QAM, 32QAM, 64QAM, 128QAM, and 256QAM signals.



Harmonic Analysis Mode

This mode supports detection and measurement of up to 10 harmonic components, including harmonic peaks, harmonic channel power, and total harmonic distortion.

Phase Noise Measurement Mode

This mode supports offset ranges from 1 Hz to 10 MHz for evaluating carrier phase stability. With the built-in automatic carrier search function, the software can quickly locate the target carrier without manual adjustment.

■ Pulse Analysis (opt.72)

This mode supports the measurement of pulse signals with a pulse width of 32ns or more, displaying key parameters such as Top level (dBm), Base level (dBm), Top/Base, Droop, Over Shoot, Ripple, Rise/Fall Time, Rise/Fall Edge, Width, PRI, and Duty Cycle.

■ EMI Pre-Compliance Measurement (opt.74)

This mode provides EMI measurement capabilities compliant with the CISPR 16-1-1 standard. It supports 6 dB EMI filter bandwidths of 200 Hz, 9 kHz, 120 kHz, and 1 MHz, as well as multiple detectors including Peak, Quasi-Peak, Average, and RMS. Combined with limit line comparison, signal list analysis, and test report export functions, it enables efficient pre-compliance measurements for radiated and conducted emissions.

Main Functions Overview

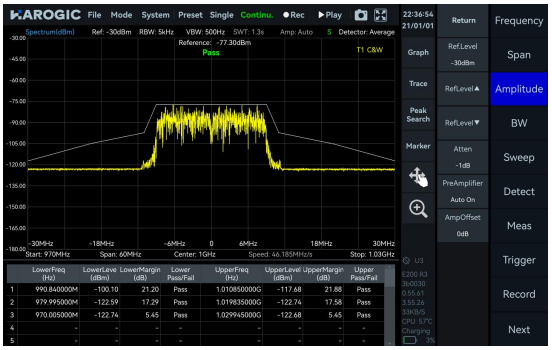
Channel Power

OBW

ACPR

IM3

SEM



AM/FM Demodulation

Antenna Factor

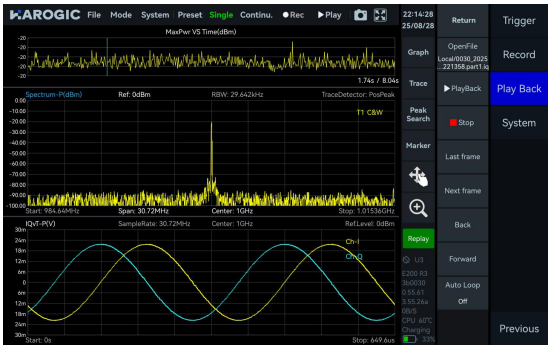
Amplitude Offset

www.harogic.com info@harogic.com +65-8299 8857

Signal Track

Peak Table

Data Record and Playback



Multiple Unit Display

Specifications*

FREQUENCY

	SAN-45	SAN-60	SAN-90
Frequency range	9 kHz to 4.5 GHz	9 kHz to 6 GHz	9 kHz to 9 GHz
Reference clock	Internal or external, manual correction or GNSS calibration is available		
Frequency accuracy	≤ 0.5 ppm Manual correction available	≤ 0.05 ppm After GNSS-based frequency correction	
Aging and temperature stability	≤ 1 ppm/year, ≤ 1 ppm		
Built-in GNSS 1PPS accuracy	≤ 100 ns		

SPECTRUM PURITY

SSB phase noise (dBc/Hz)
Guaranteed/Typical

Carrier frequency	1 GHz	4.5 GHz	6 GHz	9 GHz
100 Hz	-85 / -88	-78 / -81	-75 / -78	-74 / -77
1 kHz	-97 / -99	-90 / -93	-86 / -89	-88 / -91
10 kHz	-110 / -112	-103 / -106	-100 / -103	-99 / -102
100 kHz	-114 / -115	-104 / -107	-104 / -107	-99 / -102
1 MHz	-131 / -132	-119 / -122	-118 / -121	-116 / -119

Residual response (dBm)
RBW = 1 kHz
Guaranteed/Typical

Reference level (R.L.)	0 dBm	-50 dBm
9 kHz to 100 MHz	-90 / -94	-115 / -117
100 MHz to 4.5 GHz	-90 / -95	-120 / -128
4.5 GHz to 6 GHz	-90 / -96	-120 / -130
6 GHz to 9 GHz	-90 / -98	-120 / -129

Image rejection	>90 dBc, >95 dBc (Typical)
IF rejection	>90 dBc, >95dBc (Typical)
Local oscillator related spurious	<-65 dBc Center frequency ± (N/M) × 100 MHz, N, M = 1, 2, 3, 4, 5...

IIP3/IIP2 (dBm)
Typical

Carrier frequency	1 GHz	4.5 GHz	6 GHz	9 GHz
R.L. = 20 dBm	42/80	37/80	32/80	36/80
R.L. = 0 dBm	23/80	22/80	20/80	14/80
R.L. = -20 dBm	3/60	3/45	-1/45	-5/45

AMPLITUDE

Max. input power (CW)	23 dBm	50 MHz to maximum frequency and preamplifier is off
	10 dBm	9 kHz to 50 MHz or preamplifier is on
Max. DC voltage	±10 VDC	
Display range	DANL to 30 dBm	
Level accuracy	± 1.0 dB from 20 °C to 30 °C typical conditions	± 1.5 dB over full temperature range all conditions
IF in-band flatness	< ±1.5 dB 50MHz analysis bandwidth	< ±2.0 dB 100MHz analysis bandwidth
Reference level	-70 dBm to +23 dBm	
RF preamplifiers	Auto or manual	
VSWR	<2.0:1 Nominal, 90 MHz to Max. Frequency	

Display average noise level (DANL)
dBm/Hz Guaranteed/Typical
RBW=1 kHz

	SAN-45		SAN-60		SAN-90	
Reference level	-20 dBm	-70 dBm	-20 dBm	-70 dBm	-20 dBm	-70 dBm
9 kHz to 1 MHz	-131 / -134	-141 / -144	-131 / -134	-141 / -144	-131 / -134	-141 / -144
1 MHz to 100 MHz	-151 / -154	-163 / -166	-151 / -154	-163 / -166	-151 / -154	-163 / -166
100 MHz to 3.0 GHz	-141 / -144	-165 / -168	-141 / -144	-165 / -168	-141 / -144	-165 / -168
3.0 GHz to 4.5 GHz	-142 / -145	-165 / -168	-142 / -145	-165 /-168	-142 / -145	-165 / -168
4.5 GHz to 6 GHz	-	-	-143 / -146	-165 / -168	-143 / -146	-165 / -168
6 GHz to 9 GHz	-	-	-	-	-144 / -147	-164 / -167

STANDARD SPECTRUM ANALYSIS

Detector	PosPeak, NegPeak, Sample, Average, RMS, RawFrames, MaxPower
RBW	0.1 Hz to 10 MHz
VBW	0.1 Hz to 10 MHz
Data chart	SAStudio4 software provides spectrum, spectrogram, historical trace
Measurements	Channel power, OBW, X dB bandwidth, Adjacent channel power ratio, IM3

Sweep Speed (Spur Rejection = Bypass)	RBW = 250 kHz	FPGA processing	B-Nuttall	≥ 1 THz/s
	RBW = 25 kHz	FPGA processing	Kaiser	≥ 300 GHz/s
	RBW = 1 kHz	CPU processing	B-Nuttall	≥ 4 GHz/s

IQ RECORDING

Continuous recording bandwidth	Maximum: 50 MHz
Burst recording bandwidth	Maximum: 50 MHz / 100 MHz (opt.50) The built-in memory depth is 128 Mbytes
IQ sample rate	Maximum: 62.5 MSPS / 125 MSPS (opt.50) Decimate factor: 1, 2, 4, 8, 16, 32, 64, 128, 256, 512, 1024, 2048
External trigger response	Maximum frequency response: 500 times/s

DETECTION ANALYSIS

Min. time resolution	16 ns / 8 ns (opt.50)
Max. analysis bandwidth	50 MHz / 100 MHz (opt.50)
Detector	PosPeak, NegPeak, Sample, Average, RMS, MaxPower

REAL TIME SPECTRUM ANALYSIS

FFT analysis

FFT engine is implemented in FPGA. Frame compression and trace detection are supported. No missing samples between FFT frames

FFT frame update rate=10 ^ 9 ns/(N × D × Minimum time resolution)
POI = 2 × N × D × Minimum time resolution
N for FFT points (4096, 2048, 1024, 512, 256, 128, 64, 32)
D for decimate factor (1, 2, 4, 8...)

Typical settings	FFT refresh rate (times/s)		100%POI (us)	
	std.	opt.50	std.	opt.50
N = 4096, D = 1	15,258	30,517	131.072	65.536
N = 32, D = 1	1,953,125	3,906,250	1.024	0.512

Max. analysis bandwidth	50 MHz / 100 MHz (opt.50)
Window function	B-Nuttall, Flat-top, LowSideLobe, Rectangle, Kaiser
RBW steps	≥ 12 grades
Amplitude resolution	0.5 dB

GENERAL

Input and output	
RF input	N(F), impedance 50 Ω
Power	Type-C, 5V 3A supply capacity voltage range 4.75 to 5.25 V, ripple less than 200 mVp
USB port	Type-C, USB3.0 (USB2.0 bandwidth limited) Data communication mode: 5 V / 0.9 A power supply required Single USB Type-C power supply mode: USB PD 3.0 protocol required, 5 V / 3 A power capability
External trigger input	Integrated in AUXIO, 3.3V CMOS, high impedance
Trigger output	Integrated in AUXIO, 3.3V CMOS
GNSS antenna input	SMA (F)
Analog IF output	MMCX (F), maximum output power -25 dBm impedance 50 Ω, 312.5 MHz ± 50 MHz
External reference clock input	MMCX(F), 10 MHz, Amplitude ≥ 1.5 Vpp, impedance 330 Ω
Reference clock output	MMCX(F), 100 MHz, Amplitude ≥ 0.3 Vpp, programmable on/off

Overall / core weight	≤ 420 g / ≤ 195 g	
Overall / core dimensions (L × W × H)	≤ 163 x 66 x 37 mm / ≤ 109 x 60 x 16 mm	
Power consumption	≤ 15 W	
Packaging accessories	Flash disk * 1, USB 3.0 data cable * 1, USB power cable * 1, Power adapter * 1	
System requirements	Windows 11/10/8/7(x86, x64), Debian 12/11/10(x64, AArch64) Ubuntu 24.04/22.04/20.04/18.04(x64, AArch64)	
Operating/Storage temperature (ambient)	T0 class (std.)	0 to 50 °C / -20 to +70 °C
	T1 class (opt.40)	-20 to +65 °C / -40 to +85 °C
	T2 class (opt.41), only core	-40 to +65 °C / -40 to +85 °C
Operating relative humidity	Ambient Temp.: 0 to 40 °C	5 to 75%
	Ambient Temp.: > 40 °C	5 to 45%

PHASE NOISE MEASUREMENT

Min. frequency offset	1 Hz			
Max. measurement frequency offset	10 MHz			
Trace smooth	Support			
SSB phase noise (dBc/Hz) Guaranteed/Typical				
Carrier frequency	1 GHz	4.5 GHz	6 GHz	9 GHz
100 Hz	-90 / -94	-80 / -83	-80 / -83	-78 / -81
1 kHz	-113 / -117	-102 / -105	-100 /-103	-95 / -98
10 kHz	-120 / -125	-112 / -115	-109 / -112	-106 / -109
100 kHz	-126 / -129	-114 / -117	-111 / -114	-108 / -111
1 MHz	-136 / -139	-125 / -128	-123 / -126	-119 / -122
10 MHz	-140 / -143	-137 / -140	-137 /-140	-136 / -139

PULSE DETECTION (opt.72)

Min. pulse width	64 ns / 32 ns (opt.50)
Measurement parameters	Top Level, Base Level, Top/Base, Droop, OverShoot, Ripple, Rise Time, Rise Edge, Fall Time, Fall Edge, Width, PRI, Duty Cycle

AM DEMODULATION

Measurement parameters	Modulation depth, carrier power, modulation rate, signal-to-noise ratio, RMS power, total harmonic distortion, etc.	
Modulation rate test range	20 Hz to 10 MHz	
Modulation rate test accuracy	< 1 Hz when modulation rate < 1 kHz	< 0.1% when modulation rate ≥ 1 kHz
Modulation depth test range and accuracy	5% to 95%, ±5% (Nominal)	

FM DEMODULATION

Measurement parameters	Modulation frequency offset, carrier power, modulation rate, signal-to-noise ratio, RMS power, total harmonic distortion, etc.	
Modulation rate test range	20 Hz to 2 MHz	
Modulation rate test accuracy	< 1 Hz when modulation rate < 1 kHz	< 0.1% when modulation rate ≥ 1 kHz
Frequency offset test range and accuracy	1 kHz to 10 MHz, ±6% (Nominal)	

BASIC VECTOR MODULATION ANALYSIS (opt.71)

Modulation type	ASK: 2ASK FSK: 2FSK, 4FSK MSK: GMSK PSK: BPSK, QPSK, 8PSK QAM: 16QAM, 32QAM, 64QAM, 128QAM, 256QAM
Symbol length	128 QAM and 256 QAM: 4000 Others: 2000
Symbol rate	(1/64 to 1/4) * sample rate, ≤ 32.5 MSPS
Filter	Root raised cosine
Filter roll-off factor	0.01 to 0.99
Display	Spectrum, constellation, eye diagrams, measurement results
Measurement	EVM, amplitude error, phase error, frequency error, signal-to-noise ratio, part of the bitstream

EMI PRE-COMPLIANCE MEASUREMENT (opt.74)

EMI filter (-6 dB bandwidth)	200 Hz, 9 kHz, 120 kHz, 1 MHz
Detector	Peak, Average, RMS, Quasi-Peak (CISPR 16-1-1 compliant)
Measurement time setting range	0.1 s to 10 s
Limit line standards	FCC Part 15, EN550xx, user defined
Report output	Signal list
Frequency axis	Linear and logarithmic

*Specification applies under the following conditions:

(1) Start up and warm up for 10 minutes

(2) Ambient temperature 25 °C

(3) Typical and nominal values are not guaranteed and do not include measurement uncertainty

(4) Specifications may vary with hardware and software versions without prior notice

OPTIONS

Code		
16	0 Hz start frequency (only applicable to SAN-45)	built-in hardware
20	AUXIO IO expansion board	external hardware
23	IO expansion board with GNSS-disciplined OCXO	external hardware
40	T1 temperature class	built-in hardware
41	T2 temperature class, only available for core	built-in hardware
50	100 MHz analysis bandwidth	built-in hardware
71	Basic vector modulation analysis	software
72	Pulse analysis	software
74	EMI pre-compliance measurement	software
80	4-year warranty	service
81	5-year warranty	service

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